

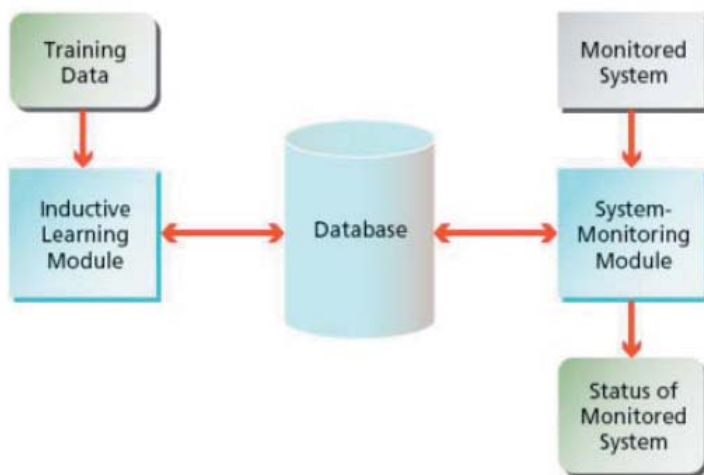


technology opportunity

Inductive Monitoring System

Automated Monitoring Techniques for Complex Systems

LEARNING/MODELING



IMS conceptual overview

Benefits

- Automated Diagnosis System – IMS-detected anomalies can be sent to a diagnostic software module for diagnosis
- Compact health information presentation displays degree of deviation from nominal performance
- Decreases workload required to monitor system health and to respond to anomalous behavior

The Inductive Monitoring System (IMS) software utilizes techniques from the fields of model-based reasoning, machine learning, and data mining to build system monitoring knowledge bases from archived or simulated sensor data. Unlike some other machine learning techniques, IMS does not require examples of anomalous (failure) behavior. IMS automatically analyzes nominal system data to form general classes of expected system sensor values. This process enables the software to inductively learn and model nominal system behavior. The generated data classes are then used to build a monitoring knowledge base. In real-time, IMS performs monitoring functions, determining and displaying the degree of deviation from nominal performance. IMS trend analyses can detect conditions that may indicate a failure or required system maintenance. The development of the IMS was motivated by the difficulty of producing detailed diagnostic models of some system components due to complexity or unavailability of design information. Previous and current IMS applications include the Hybrid Combustion Facility (HCF), the advanced rocket fuel test facility, and the RASCAL UH-60 Blackhawk Helicopter.

Technical Basics

- Monitoring Knowledge Base – IMS “learns” and models typical system behavior using nominal data sets collected directly from the system or from simulations
- Fault-detection – correlates real-time data to archived data sets using various algorithms to determine whether certain system behavior is normal or abnormal
- Health management – uses results to make appropriate decisions about corrective maintenance actions based on the system health information
- Automated system health monitoring – monitors devices automatically while they are operating in order to ensure that the device is operating properly

Technology Details

How It Works

The Inductive Monitoring System (IMS) software provides a method of building an efficient system health monitoring software module by examining data covering the range of nominal system behavior in advance and using parameters derived from that data for the monitoring task. This software module also has the capability to adapt to the specific system being monitored by augmenting its monitoring database with initially suspect system parameter sets encountered during monitoring operations which are later verified as nominal.

While the system is off line, IMS learns nominal system behavior from archived system data sets collected from the monitored system or from accurate simulations of the system. This training phase automatically builds a “model” of nominal operations, and stores it in a knowledge base. The basic data structure of the IMS software algorithm is a vector of parameter values. Each vector is an ordered list of parameters collected from the monitored system by a data acquisition process. IMS then processes select data sets by formatting the data into a predefined vector format and building a knowledge base containing clusters of related value ranges for the vector parameters.

In real time, IMS then monitors and displays information on the degree of deviation from nominal performance. The values collected from the monitored system for a given vector are compared to the clusters in the knowledge base. If all the values fall into or near the parameter ranges defined by one of these clusters it is assumed to be nominal data since it matches previously observed nominal behavior. The IMS knowledge base can also be used for off line analysis of archived data.

Applications

IMS can be used to monitor nearly any system with recurring behavior and appropriate data collection. This allows application to any number of system monitoring tasks. IMS applications under development include telescope subsystems, uninhabited aerial vehicles, spacecraft, and aircraft.

Patents

This technology has been patented (U.S. Patent 7,383,238).

Licensing and Partnering Opportunities

NASA Ames is currently seeking U.S. companies interested in further development of this technology. A patent application has been submitted and opportunities for licensing and development partnerships exist.

For More Information

If you would like more information about this technology, please contact:

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